

FINGER SEAL DEVELOPMENT FOR A COMBUSTOR APPLICATION

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Finger Seal Development for a Combustor Application

presented at

NASA Seal/Secondary Air System Workshop
NASA Glenn Research Center
Cleveland, Ohio

by

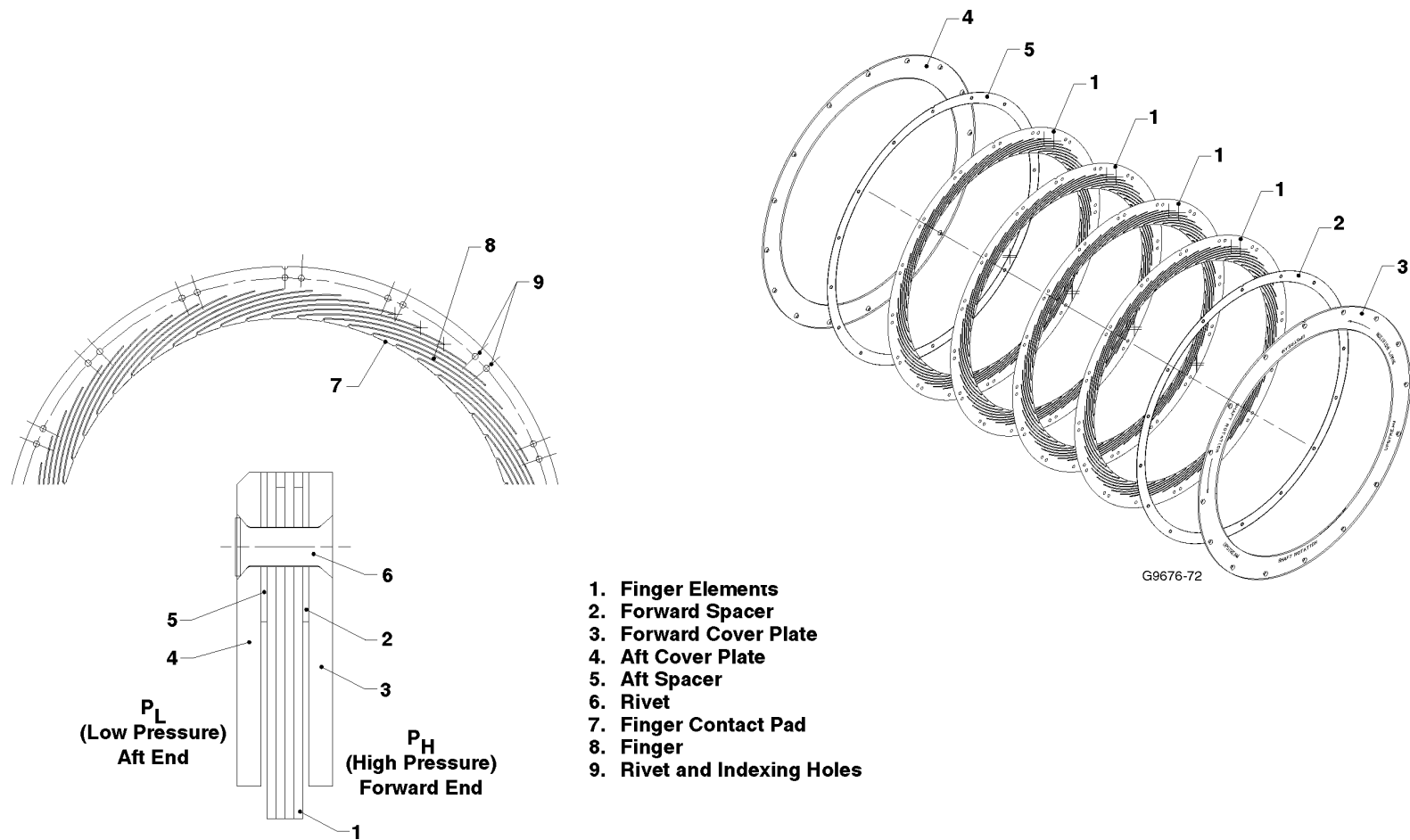
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NASA Glenn Research Center, Cleveland, Ohio.

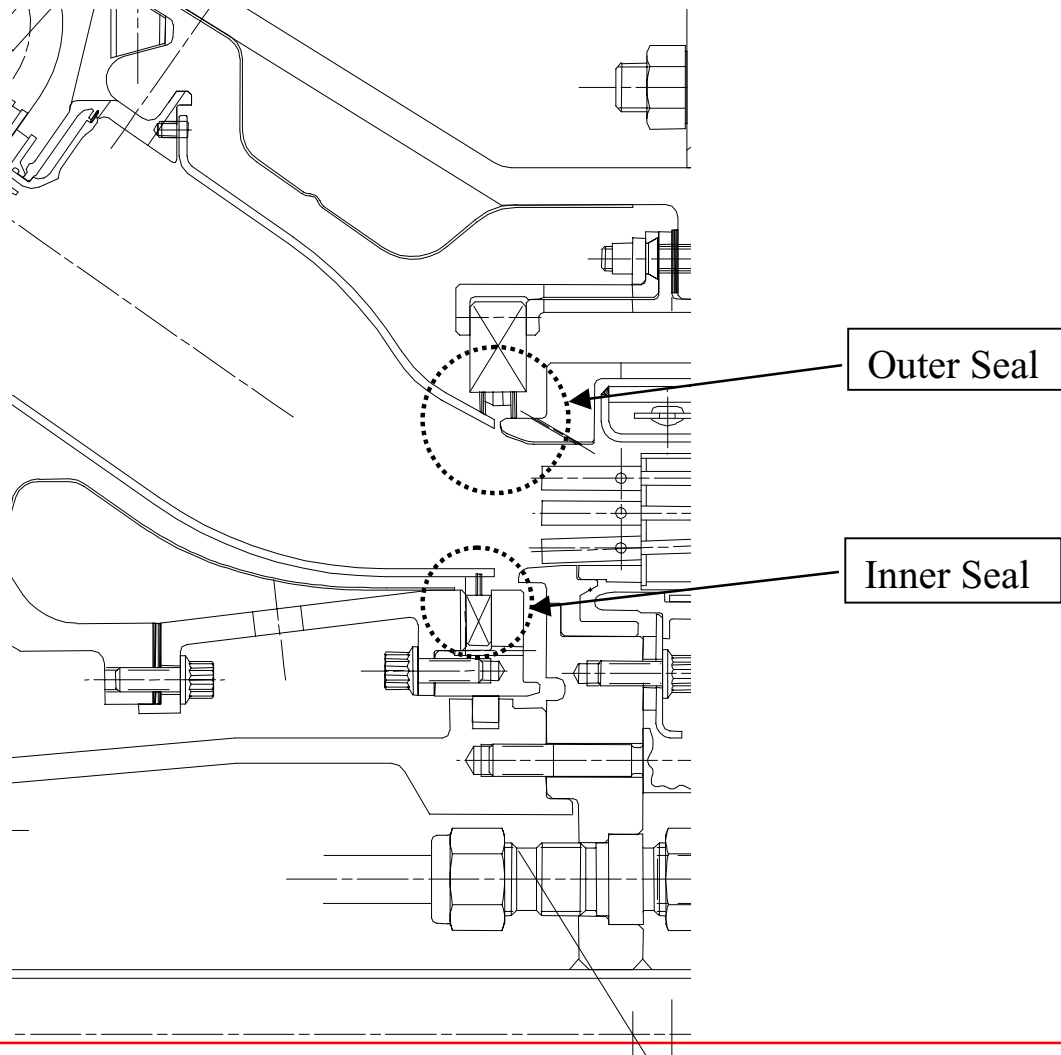
Finger seal laminate stack design ...



... leads to low manufacturing cost

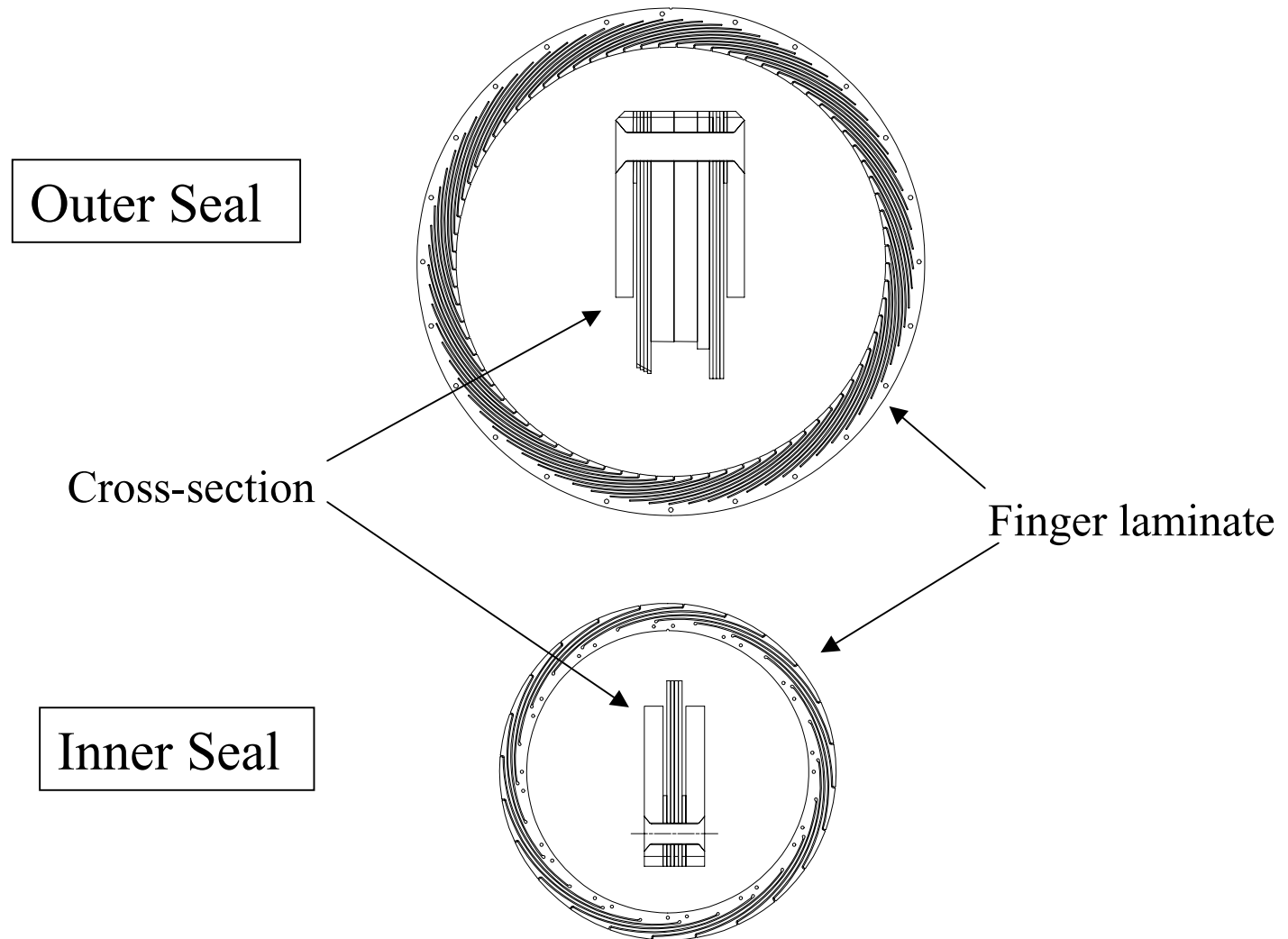
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Engine Layout showing Seal Locations



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Seal cross-section and laminates



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Design Requirement

Engine Requirement

- 6,000 hours operational life
- 7,500 LCF cycles for hot parts

Finger Seal Requirement

- Low radial force applied on CMC combustor liner under all conditions
- Radial deflection capability as below :

	Radial Deflection		
	Build	Steady State	Max Transient
Outer seal (without combustor offset)	0.002"	0.032"	0.044"
Inner Seal (without combustor offset)	0.050"	0.028"	0.015"

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Finger seal material

Materials being considered

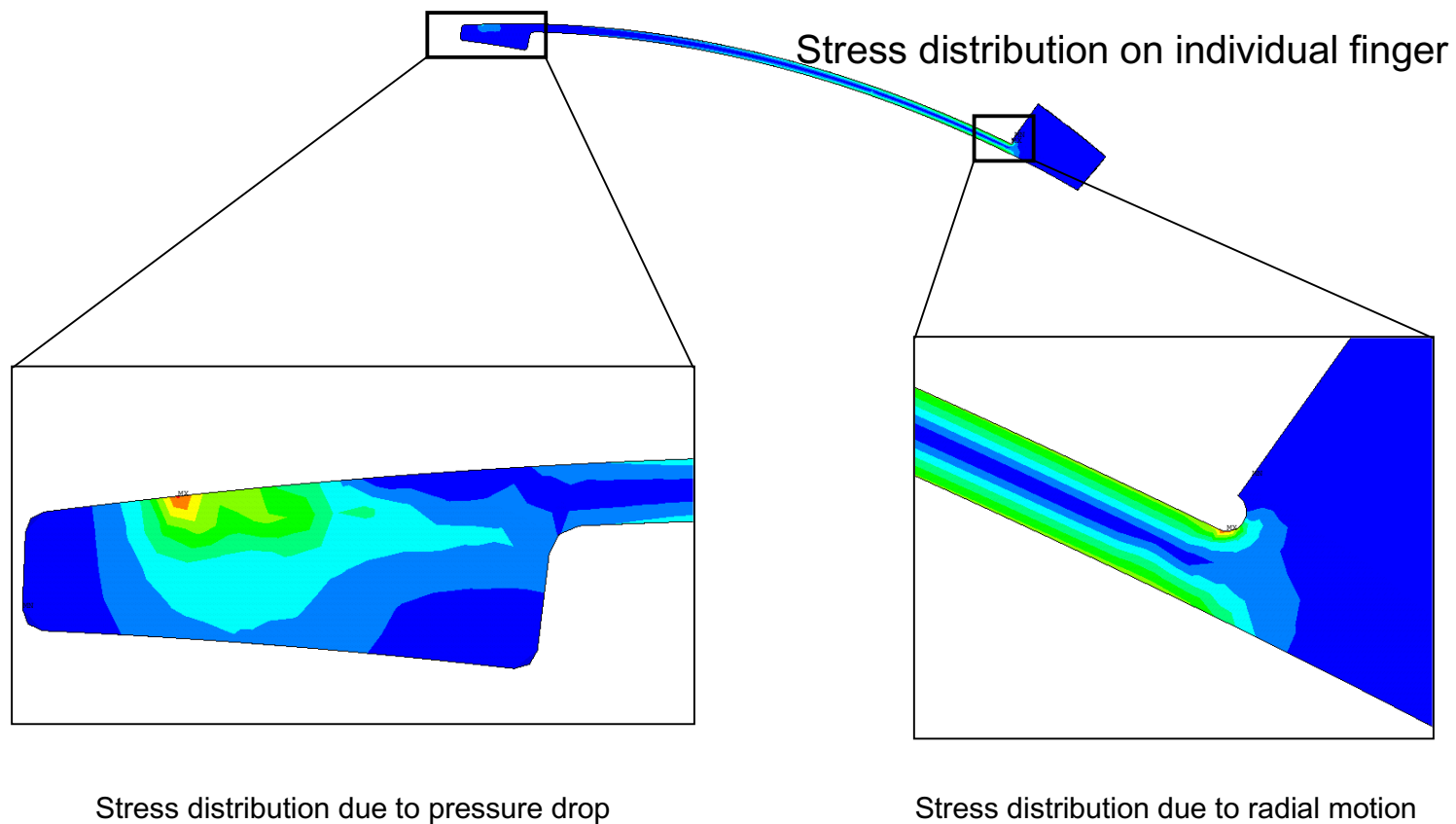
- AS800 mono-ceramic (Silicon Nitride)
- MA-956 (Fe based high temperature superalloy, high creep resistance,)
- Haynes-188 (Co based high temperature superalloy, good oxidation resistance)

Materials used for the test

- MA-956 for inner seal
- Haynes-188 for outer seal

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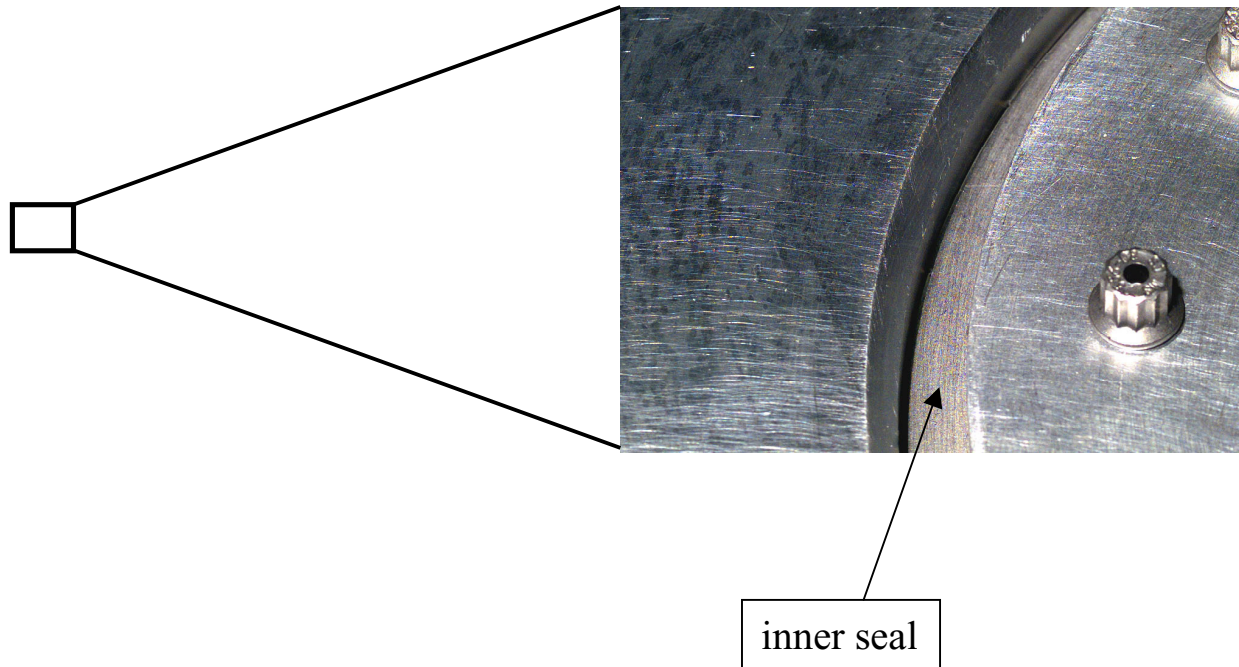
Finite Element Analysis was used...



... to ensure meeting design requirements

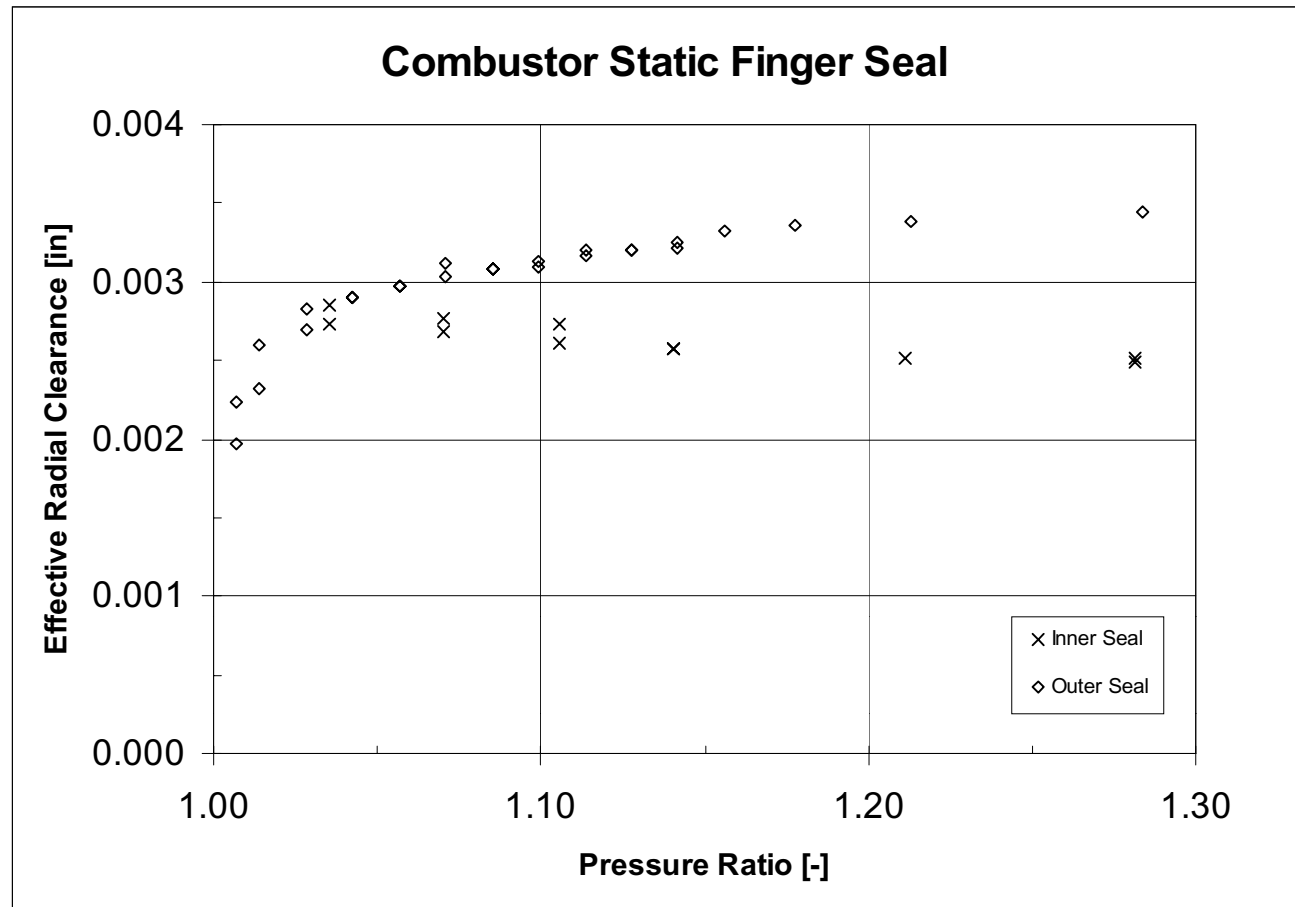
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Cold flow testing at operating interference



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Cold flow testing data...

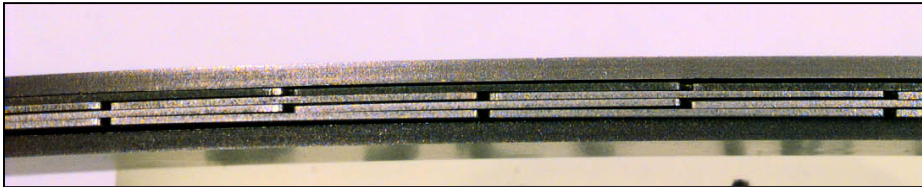


... validated design air leakage

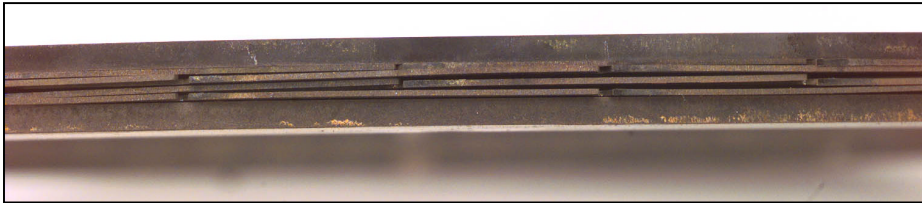
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Inner seal : pre- and post-test comparison...

Material: MA-956 (Fe based superalloy)



pre-test laminates



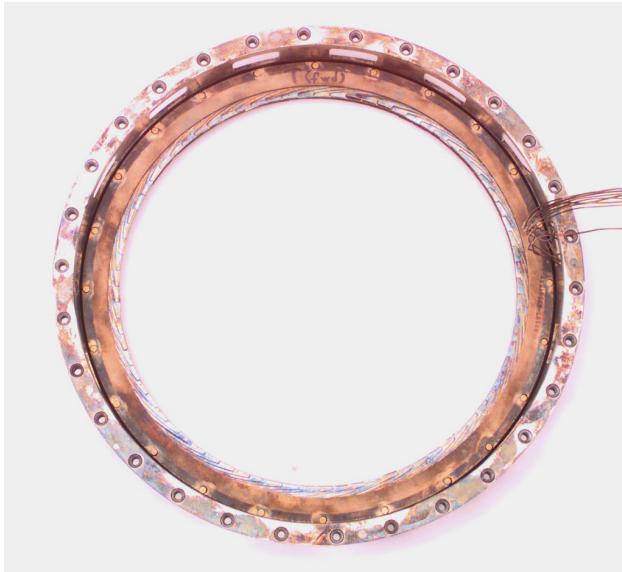
post-test laminates

... showed superficial oxidation but no distress

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Outer seal : post-test inspection...

Material: HA-188 (Co based superalloy)



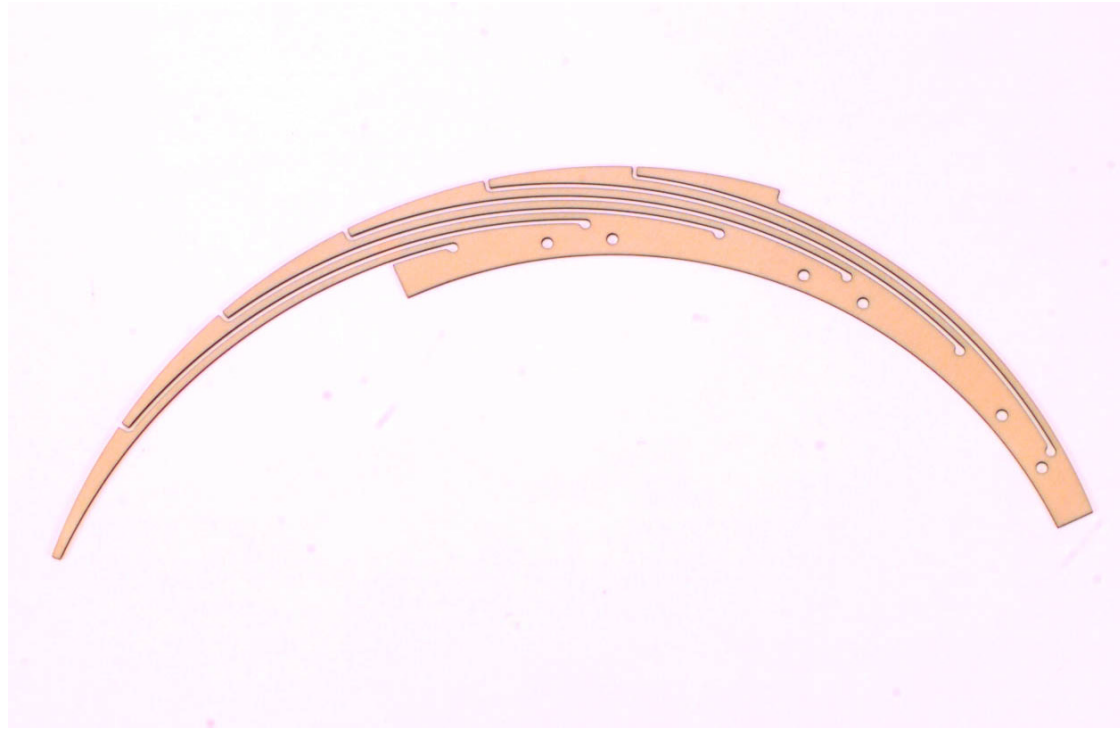
post-test laminates



... showed slight handling damage but no distress

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Seal material: AS800 mono-ceramic



- **Ceramic Components, Honeywell**, has developed cost-effective manufacturing feasibility of AS800 mono-ceramic laminate segments.
- Full scale ceramic seal testing planned in 2001.

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Conclusions

- **Finger seals met sealing requirements of a CMC (ceramic matrix composite) combustor**
- **Finger seals were found to be a cost effective option for CMC combustor sealing**
- **High temperature superalloys were investigated as potential finger seal materials**
 - **HA188, MA956 meet rig requirements**
 - **AS800 mono-ceramic being developed for engine**

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